PROCEEDINGS
OF THE
ROYAL SOCIETY OF EDINBURGH.

VOL. III. 1852–53. No. 43.

Seventieth Session.

Monday, 6th December 1852.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read :—

1. On a supposed Meteoric Stone, alleged to have fallen in Hampshire in September 1852. By Dr George Wilson.

The object of this communication was to exhibit to the Society a mineral which had been publicly described as a meteoric stone, picked up by a witness of its fall. The author had been induced, by the published account of the alleged fall of the stone, to make inquiry concerning it, and had ascertained that no one had witnessed its descent; and that the only evidence in favour of its being a meteorite was the fact of its having been noticed for the first time in a garden-path, the morning after a thunder-storm.

The mineral had not the characters of any known meteorite, being simply a large nodule of iron pyrites or bisulphuret of iron, oxidised at the surface into brown hæmatite.

The author drew attention to the fact that such nodules were popularly known, in the chalk districts of England, as "thunderbolts," a title which seemed to him a recognition of the fall of aerolites, and especially of meteoric iron, which, after oxidation, would closely resemble the oxidised pyrites.

In Scotland and the north of Europe, the term "thunderbolt" had long been applied to ancient flint arrow-heads and stone celts; and throughout the island a well-known fossil, the *belemnite*, had received the same appellation. The author did not regard those bodies as named primarily in reference to meteorites, but rather as representing the popular idea of lightning as something shot like an arrow from a thunder-cloud.

The paper concluded with the suggestion that the art of working iron had been learned by primitive nations from the manipulation of metallic meteorites, the rusting of which further taught them that brown and red hæmatite contain iron.

2. On the Glacial Phenomena of Scotland, and parts of England. By Robert Chambers, Esq.

This paper commenced with an account of *Ancient Moraines connected with Corries or Small Valleys.* Sir Charles Lyell had described one as forming the retaining dam of Loch Brandy, on the eastern skirts of the Grampians, and Mr Charles Maclaren had discovered another in Glenmessan, near the Firth of Clyde. The author of the paper described a few others which he had discovered. At Corryhashtel, on the side of Ben-Blaven, in the Isle of Skye, there are three distinct parallel lines of blocks along the right side of the valley, which are presumed to mark the right skirt of a local glacier at three points in the history of its shrinking. In a deep rough valley at the opposite side of the mountain, there are several mounds of rough stones mingled with smaller detritus, which are presumed to have been the terminal moraines of a glacier once filling that valley. The author has likewise found detrital heaps and ridges, fully answering the character of moraines, in connection with various *corries* or short valleys in the alpine districts of Applecross in Ross-shire, and Assynt in Sutherlandshire, and in some of these instances he has found the rocks in the valleys presenting smoothed and scratched surfaces.

The next section of the paper related to *Proofs of Ancient Glaciers in limited Mountain Districts.* The author had recently ascertained that the Lake District of Cumberland and Westmoreland bears incontestable traces of the former existence of glaciers originating in its high grounds, and passing down the valleys. In Borrowdale, in Ulleswater, in Thirlmere, in Grasmere, and Windermere, and in the vale of the Kent, rounded hummocks of rock, presenting an exposed side up the valley, and a rough side in the contrary direction, are abundantly seen. Flat surfaces of rock, finely smoothed and striated in the line of the valley, are presented at Grange in Borrowdale, at Patterdale in Ulleswater, and at Staveley in Kentdale. In many places, detrital accumulations of precisely the character of the moraines of the Alps, and of a brown colour, are found; but they have not been seen in any definite arrangement suggesting the idea of terminal or lateral moraines, excepting in one instance near the head of the Thirlmere valley, where a long mound of blocks rests on the hill-face, in the angle between the principal and a side valley,—a form exactly resembling the ancient moraine of the extended Glacier des Bois, at Tines in Chamouni. At Dunmail-raise, which is a col or summit out of the range of any possible glacier of the district, there is a deep accumulation of clayey matter and blocks, which the author thinks probably of greater antiquity than the glaciers of the district, and referable to earlier phenomena of a kindred character.

The author adverted to Snowdonia, in North Wales, as an ancient glacier district, of precisely the same character as that of the Cumbrian Lakes; there being here seven radiating valleys, all containing the usual proofs of the passage of ancient glaciers. These have been described several years ago, and now Professor Ramsay discovers the remarkable fact that the northern drift, which abounds in neighbouring districts, is here only found in out-of-the-way corners, and in elevated situations.

Mountain regions so limited and definite as those of North Wales and Cumbria do not exist in Scotland; but the author has nevertheless found proofs of local systems of glaciers almost equally well defined. He points to one instance in Assynt, Sutherlandshire, where there is proof of one glacier passing along through the vale in which Loch Assynt lies, and out to sea at Storr; while another, descending from the same elevated ground at Ben-Uie and Ben-More, moved along the valley which contains the estuary of Kyle Skow.

The paper next proceeds to bring forward *Proofs of a more General Glaciation in Scotland.*

Traces of glacial action in the smoothing and furrowing of rocks, and in the deposit of the appropriate detrital accumulations and blocks, have heretofore been detected in various parts of Scotland. In the southern and eastern skirts of the Highlands, the direction indicated for the agent is southerly and easterly. In the valley of the Firth of Forth, both in the low grounds, and high up the hills on both sides, are phenomena of this kind, with an indication of direction from about WSW. Having found a few instances in the north of Argyllshire and parts of Inverness-shire, where the agent appeared to have had a direction from the east, Mr Maclaren and M. Charles Martins had become satisfied that there had been ordinary glaciers in the group of mountains between the Clyde and Lochaber, and that they had, as usual, radiated outwards. Thus it was held as possible to account for the whole phenomena which had been observed.

The author of the present paper has extended his observations to the large Highland district to the northward of the great glen, and particularly to the old red sandstone district of western Ross and Sutherland. He has there found glacially-smoothed rocks, even more abundantly than in the southern region. They occur in many valleys, generally in the line of the valleys, and also on many elevated situations, even to 2000 feet above the level of the sea. In all elevated positions, and in all open regions free of valleys, the line of the striation shews a marked tendency to observe one direction, and that between north-west and south-east. This is alike the case in Mull and in Skye, on Ben-Eay beside Loch Maree in Ross-shire, and on the mountains of Cuineag and Canisp in Sutherlandshire, in the wide-spread rocky plains of Lord Reay's country, and on the gentle undulations of Caithness. The white quartz rocks of the Assynt mountains retain the striation over wide areas and with great clearness. It is also remarkable that some of these mountains are of a narrow lengthy form, with the longitudinal axis in the same direction as the striation, while the intermediate hollows, containing the long lakes for which the district is remarkable, observe the same direction. The whole series of the old red sandstone mountains of Ross and Sutherland, extending for fifty miles, observe a horizontal stratification, so that each separate hill looks like a pile of masonry resting on a gneissic platform. Finding the hills themselves, and the intermediate spaces, marked glacially, and the glacial striæ, and the lengths of the hills and intermediate hollows, all conformable in direction, the author of the paper thinks it probable that ice, not water, will yet be concluded to have been the cause of this notable example of the phenomenon of Denudation; and, consequently, of many others where its operations have not as yet been suspected.

It is in the midst of this district of old red sandstone mountains, that the author discovered the traces of local glaciers passing through the vale of Loch Assynt, and that containing the estuary of Kyle Skow. These consisted of moraines damming up lakes in the high grounds,—smoothed hummocks and ridges of rock in the valleys, with the exposed side towards the supposed sources of the glaciers, and trains of brown debris in the opposite direction,—and blocks of the gneissic platform of the country carried in the latter direction over the crust of old red sandstone on the coast. The direction of the striation in these instances, is different from that above described, and at one place, on the skirts of Canisp mountain, above a valley containing many moraines, the normal striation from the north-west is crossed, like the chequers of cloth, by another system traceable to an agent which has passed right down hill.

The author considers these facts as indicating that there has been, *first*, a general sweeping of the surface in that district by some icy agent, which has come from the north-west, and been all but wholly indifferent to the inequalities of the ground; and, *second*, systems of local glaciers which have passed over certain portions of the ground, substituting their own peculiar set of tracings and memorials for those of the previous movement. And thus he considers himself as having obtained a key to much that was perplexing in the glacial phenomena of the southern portions of the Highlands. Having in Lochaber,—where Mr Maclaren had found in the valleys traces of a westerly movement,—seen on the higher grounds the clearest memorials of one to the south-eastward and eastward, he believes that the former instances are merely results of later and more local glaciation, the direction of which was of course determined by the descent of the valleys; while it remains true of this, as of the more northern districts, that a general sweeping of the surface, irrespective of hill and valley, had taken place at an earlier period. The author conceives that the smoothings of valleys still more to the southward, as those of the Gareloch, discovered by Mr Maclaren, and those of Loch Lomond and Loch Katrine, discovered by himself, as well as those of the valley of the Forth, may all be classed under the earlier and more general glaciation, though not perhaps in any place free from some interferences of the later and more local movements. He asserts that every part of the Highlands, and much of the Lowlands, bear traces of this general glaciation, in the rounding and smoothing of rocks, though in many instances, the effects are comparatively obscure, in consequence of weathering, and the washing of the rock-surface by superficial accumulations. The author indicated a new kind of memorial of these glacial operations, in what he described as *Mouldings*, seen on the sides of many hills in Scotland, generally nearly horizontal, resembling the mouldings produced in wood by the use of a curve-edged plane, and which he considers as connecting themselves on the one hand, with such longitudinal ridges as the Garleton Hills, all lying in the direction of the striation of the district; and, on the other, with the rounded and flowing outlines of such larger hills as the Pentlands, on which they are themselves marked. The whole phenomena, in the opinion of the author, demand the passage, over large areas of unequal country, of some agent at once plastic and fitted to apply with keen abrading force to the surface; at the same time in such volume as to fill valleys several miles in breadth, and from one to two thousand feet in depth. He contended that, as respects all these glacial phenomena, Scotland is in precisely the same condition as Scandinavia, where there are proofs of a general movement from the north-west, though turning easterly in the southern district; the valleys on the shores of the Northern Ocean, and White Sea, which shewed proofs of glaciation in the seaward direction, being seats of comparatively modern and local glaciers. The same doctrine applied to North America.

In speculating on the nature of the agent, the author could not profess to speak with much confidence; but he thought that, in dismissing the disproved Dilatation Theory of Charpentier and Agassiz, it would be well to keep in view, that there was no theoretical objection to a flow of glacier ice over wide areas of small inclination, if the latter circumstance were compensated by the volume of the mass; and it even appeared that, on the hydrostatic principle, an accumulation of the materials in one quarter, would cause a movement towards any other quarter offering sufficiently small resistance. The agent, however, appeared to have been applied in different conditions from a subaerial glacier, at least as far as Scotland was concerned, for the boulder clay of many districts of our country must be considered as the detritus of this general glaciation; and that shewed, in the author's opinion, proofs of the presence of water, both in the compactness of the clay, and in the roundedness of the boulders. Glacier ice moving on a flat surface, even supposing no sea present, would obviously be different from a glacier in a sloping valley, because it would not undergo the same drainage of the included water. It would be in a comparatively slushy condition; and, by the way, so much the more mobile.

The latter part of the paper was devoted to a summary of ascertained facts regarding the superficial accumulations of different countries. The Drift of the Silurian region, described by Sir Roderick Murchison, answered to the Scottish Boulder Clay, in the local character of the included blocks, and the direction in which it had moved. Over and posterior to it, was the Northern Drift, so widely spread in England. This probably corresponded with a second boulder clay or Till, known to Scottish geologists, and which, differing in some respects from the first, might be presumed to be owing to somewhat different causes, or to similar agents operating under different circumstances, the sea being here undoubtedly concerned. The local glaciers of Wales have already been shewn to be later than this drift. In clays and sands below and above the second boulder clay, are found, in Scotland, deposits of shells of living species, but betraying an Arctic character.

The following Gentlemen were duly elected as Ordinary Fellows:—

1. **Alex. James Russell**, Esq., C.S.
2. Dr **Andrew Fleming**, H.E.I.C.S., Bengal.

The following Donations to the Library were announced:—

Journal of the Statistical Society of London. Vol. XV., Parts 1, 2, 3. 8vo.—*From the Society.*

Journal of the Horticultural Society of London. Vol. VII., Parts 2 & 3. 8vo.—*From the Society.*

Journal of Agriculture, and the Transactions of the Highland and Agricultural Society of Scotland. N.S. Nos. 37 & 38. 8vo. —*From the Society.*

Quarterly Journal of the Chemical Society. Vol. V., Nos. 2 & 3. 8vo.—*From the Society.*

Quarterly Journal of the Geological Society. Vol. VIII., Parts 2, 3, 4. 8vo.

Address delivered at the Anniversary Meeting of the Geological Society of London, on the 20th of February 1852. By William Hopkins, Esq. 8vo.—*From the Society.*

Journal of the Geological Society of Dublin. Vol. V., Part 2. 8vo. —*From the Society.*

Journal of the Asiatic Society of Bengal. N.S. Nos. 46, 50, 51, 52, 53, 54. 8vo.—*From the Society.*

Transactions of the Achitectural Institute of Scotland. Vol. II., Parts 3, 4, 5. 8vo.—*From the Institute.*

The Assurance Magazine, and Journal of the Institute of Actuaries. Nos. 6, 8, 9. 8vo.—*From the Institute.*

Scientific Memoirs, selected from the Transactions of Foreign Academies of Science and learned Societies. Edited by Richard Taylor, F.S.A. Vol. V., Part 20. 8vo.—*From the Editor.*

Address at the Anniversary Meeting of the Royal Geographical Society, 24th May 1852. By Sir R. I. Murchison. 8vo.

Catalogue of the Library of the Royal Geographical Society. 8vo. —*From the Society.*

Proceedings of the Royal Irish Academy. Vol. IV., Parts 2 & 3. Vol. V., Part 1. 8vo.—*From the Academy.*

Annals of the Lyceum of Natural History of New York. Vol. V., Nos. 3–14. 8vo.—*From the Lyceum.*

Medico-Chirurgical Transactions. Published by the Royal Medical and Chirurgical Society of London. Vols. XXIV. & XXV. 8vo.— *From the Society.*

Proceedings of the Philosophical Society of Glasgow. 1851–2. Vol. III., No. 4. 8vo.—*From the Society.*

Nineteenth Report of the Scarborough Philosophical Society. 1850. 8vo.—*From the Society.*

Twenty-ninth Annual Report of the Royal Asiatic Society of Great Britain and Ireland. 1852. 8vo.—*From the Society.*

Nineteenth Annual Report of the Royal Cornwall Polytechnic Society. 1851. 8vo.—*From the Society.*

Annual Reports of the Leeds Philosophical and Literary Society. 1832–52. 8vo.—*From the Society.*

Proceedings of the American Association for the Advancement of Science. 1848, 1850, 1851. 8vo.—*From the Association.*

A Notice of the Origin, Progress, and Present Condition of the Academy of Natural Sciences of Philadelphia. By W. S. W. Ruschenberger, M.D. 8vo.—*From the Academy.*

Collection of Reports from the Secretary of the Treasury of the American Government on scientific subjects. 8vo.—*From the American Government.*

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. V., Nos. 10 & 12. Vol. VI., Nos. 1 & 2. 8vo.—*From the Academy.*

Exploration and Survey of the Valley of the Great Salt Lake of Utah, including a reconnoissance of a new route through the Rocky Mountains. By Howard Stansbury, Capt. T.E., U.S. Army. With Plates. 8vo.—*From the Author.*

The Mastodon Giganteus of North America. By John C. Warren, M.D. 4to.—*From the Author.*

Regi Magyar Nyelvemlékek. Kötet. 1, 2, 3. 4to.

A' Magyar Tudós Társásag' Evkönyvei. Kötet. 3, 4, 6, 7. 4to.

Hunyadiak Kora Magyarországou. irta Gróf Teleki Jozsef. 1 Kötet. 8vo.—*From the Literary Society of Hungary.*

Fifth Annual Report of the Board of Regents of the Smithsonian Institution for 1850. 8vo.

On Recent Improvements in the Chemical Arts. By Prof. James C. Booth and Campbell Morfit. 8vo.—*From the Institution.*

Catalogue of Stars near the Ecliptic, observed at Markree during the years 1848, 1849, & 1850, and whose places are supposed to be hitherto unpublished. Vol. I. 8vo.—*From H. M. Government.*

Proceedings of the American Philosophical Society. Vol. V., No. 47. 8vo.—*From the Society.*

Catalogue of the Library, and Constitution and Laws of the Institute of Actuaries of Great Britain and Ireland. 8vo.—*From the Institute.*

Mémoires présentés pars divers Savants à l'Académie des Sciences de l'Institut National de France. Sciences Mathématiques et Physiques. Tome XIII^{me}. 4to.—*From the Academy.*

Recherches sur la Conductibilité des Minéraux pour l'Electricité Voltaïque. Par M. Elie Wartmann. 4to.—*From the Author.*

Flora Batava. 16 Aflev. 4to.—*From the King of the Netherlands.*

Historische en Letterkundige Verhandelingen van de Hollandsche Maatschappij der Wettenschappen te Haarlem. I^{te} Deel. 4to. —*From the Society.*

Nieuwe Verhandelingen van het Bataafsch Genootschap der Proefondervindelijke Wijsbegeerte te Rotterdam. XI^{te} Deel. 4to.—*From the Society.*

Det Kongelige Danske Videnskabernes Selskabs Skrifter. Femte Række. Naturvidenskabelig og Mathematisk Afdeling. Andet Bind. 4to.—*From the Academy.*

Abhandlungen der Mathematisch-Physischen Classe der Königlich Sächsischen Gesellschaft der Wissenschaften. Band. I. 8vo.—*From the Society.*

Naturwissenschaftliche Abhandlungen, gesammelt und durch subscription herausgegeben von Wilhelm Haidinger. Band IV. 4to.—*From the Editor.*

Archives du Muséum d'Histoire Naturelle, publiées par les Professeurs-Administratifs de cet Etablissement. Tome V., Liv. 4; Tome VI., Liv. 1, 2, 3, & 4. 4to.—*From the Society.*

Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe. Band. III. 1te. & 3te Lieferungs. Fol.

Sitzungsberichte der Kaiserlichen Akademie der Wissenchaften. Mathematisch-Naturwissenschaftliche Classe. 1851; Band VII., 3, 4, & 5 Hefte: & 1852; Band VIII., 1, 2, 3 Hefte. 8vo.—*From the Academy.*

Almanach der Königliche Akademie der Wissenchaften. 1852. 12o.—*From the Academy.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt. 1851; Nos. 1, 2, 3, & 4. 1852; No. 1. 8vo.—*From the Association.*

Mémoires de la Société Nationale des Sciences d'Agriculture et des Arts de Lille. Année 1850. 8vo.—*From the Society.*

Die Fortschritte der Physik im Jahre 1848. Dargestellt von der

Physikalischen Gesellschaft zu Berlin. 8vo.—*From the Society.*

Bulletin de la Société de Géographie. 4^me^ Série. Tomes II. & III. 8vo.—*From the Society.*

Manuel de la Navigation à la Côte Occidentale d'Afrique. Par M. Charles Philippe de Kerhallet. 2 Tomes. 8vo.

Annales Hydrographiques, Recueil d'Avis, Instructions, Documents et Mémoires relatifs á l'Hydrographie et à la Navigation, publié par le Dépôt-Général de la Marine. Tomes 4^{me} & 5^{me}. 8vo.—*From the Dépôt-Général de la Marine, Paris.*

Tafeln zur Reduction der in millemetern abgelesenen Barometerstände auf die Normaltemperatur von 0° Celsus. Berechent von J. J. Pohl & J. Schabus. 8vo.

Tafeln zur Vergleichung und Reduction der in verschiedenen Längenmassen Abgelesenen Barometerstände. Von J. J. Pohl & J. Schabus. 8vo.—*From the Authors.*

Transactions of the Royal Irish Academy. Vol. XXII., Parts 1 & 2. 4to.—*From the Academy.*

American Journal of Science and Arts. Vol. XIV., No. 42. 8vo. —*From the Editors.*

Smithsonian Contributions to Knowledge. Vols. III. & IV. 4to. —*From the Smithsonian Institution.*

Schoolcraft's History of the Indian Tribes. Part II. 4to.—*From the American Government.*

Astronomical Observations made at the Royal Observatory, Edinburgh, by the late Thomas Henderson, Esq. Reduced and edited by Charles Piazzi Smyth, Esq. Vol. X. 1844-5-6-7. 4to.—*From the Observatory.*

Monday, 20th December 1852.

Dr CHRISTISON, Vice-President, in the Chair.

The following Communication was read:—

On the supposed occurrence of Works of Arts in the Older Deposits. By James Smith, Esq. of Jordanhill.

The author, after mentioning various cases of this nature, in all of which the evidence was very defective, exhibited a tool of wrought-iron, said to have been found in the coal, but which was only proved to have come out of a coal-pit.

He then shewed an Indian arrow-head in a calcareous deposit *in situ* from Canada, which, at first sight, might be supposed to be coeval with the formation of the deposit; but on examination, the calcareous mass proved to be quite superficial, so that nothing could be easier than for the arrow-head, which is of the usual Indian form, to have fallen on the wet surface, and to have been thus apparently imbedded. The author concluded that no evidence had yet been adduced to prove the occurrence of works of art in any of the older deposits.

Tuesday, 4th January 1853.

Dr MACLAGAN in the Chair.

The following Communications were read:—

1. On the Optical Phenomena and Crystallization of Tourmaline, Titanium, and Quartz, within Mica, Amethyst, and Topaz. By Sir David Brewster, K.H., D.C.L., F.R.S., and V.P.R.S. Edin.

1. The first part was on the distribution of *Tourmaline in Mica.*—When liquids or gases have been confined in mica, they have often easily escaped and spread between the plates. Crystals, both of tourmaline and quartz, are found in mica, contemporaneous with it, and of considerable size. Such crystals generally have the faces of the hexagonal prism parallel to the laminæ of the mica.

But other crystals of tourmaline formed subsequently, and between the laminæ, are very different. They are hexagonal plates, with faces perpendicular to the axis of the prism. Some of the fluid which deposited them has penetrated between the laminæ, and there deposited hexagonal plates, often in circular groups round the cavity. The centre of the cavity is occupied by a granular opaque group of crystals. The hexagonal plates are commonly of a brownish yellow, and, if thicker, green ; but they are of extreme thinness. Some of them exhibit dichroism by polarized light.

The effects of pressure are detected on the mica near the cavities, proving the force exerted.

The plates of mica exhibit Newton's rings on certain circular spaces, indicating the presence of air or gas between the laminæ ; and it is curious that wherever a cavity has projected liquid or gas, it is situated on the circumference of one of these round spots. This indicates that a gas has been projected between the laminæ.

The author then described a remarkable specimen, given him by Dr Fleming, in which very thin hexagonal crystals of tourmaline, in mica, were almost opaque. There are rectilineal cracks in them, however ; and these, on looking at the sun through the crystals, exhibit very beautiful optical phenomena. These fissures prove that the crystals were soft after they had their present form. No cavity appears in this specimen.

This specimen, as well as others, contained the filaments and sporules of *Penicillium glaucum* between the laminæ.

2. *On Titanium in Mica.*—Titanium occurs in mica, and often in beautiful dendritic forms, mostly opaque, but when $\frac{1}{2000}$th of an inch thick, transparent. When only a very thin film of mica is left over them, the most beautiful colours are seen, due to the thin plate of mica, and not to a vacuity.

3. *On the occurrence of Quartz in Mica.*—The quartz occurs with its axis of double refraction parallel to the laminæ, but it never occurred in regular crystals.

4. *On Titanium in Amethyst.*—The titanium was found in fine pyramidal crystals, coating the faces as with a powder, but covered again with amethyst faces parallel to those within. The dust was formed of spicular crystals crossing each other at angles of 60° and 30°.

It would appear that the crystals of amethyst must have grown in a solution which at times contained titanium, and at other times did not. Hence the successive layers as the crystals grew. In one case, the titanium formed the external surface in part of the faces of the pyramid, as if the other part had lain in a liquid protected from the deposit, and no more amethyst had afterwards been deposited.

5. *On Titanium in Topaz.*—A number of imperfect crystals of

topaz contained titanium of a scarlet colour and transparent. These had seven different forms, some of them very curious, which are figured.

6. *On Crystals and Cavities in Garnet.*—These are very frequent, and exhibit very singular phenomena by polarized light. The cavities are sometimes surrounded by spaces or sectors of polarized light, indicating that the garnets had been soft after assuming their present forms.

In one case, a liquid or gas had escaped from a cavity, and had left circular crystals of singular beauty.

2. On the Absolute Zero of the Perfect Gas Thermometer; being a Note to a Paper on the Mechanical Action of Heat. By W. J. Macquorn Rankine, Esq.

Temperature being measured by the pressure of a perfect gas at constant density, the absolute zero of temperature is that point on the thermometric scale at which, if it were possible to maintain a perfect gas at so low a temperature, the pressure would be null.

As no gas is entirely devoid of cohesion, the immediate results of experiment give only approximations to the position of this absolute zero. These approximate positions approach nearer to the true position as the gas is rarefied.

The author having deduced the true position of the absolute zero from M. Regnault's experiments on atmospheric air and carbonic acid, soon after their publication, announced the result in the Edinburgh New Philosophical Journal for July 1849, and in the Transactions of the Royal Society of Edinburgh, vol. xx.

The present paper gives the details of the method of determination which he adopted, and a copy of the diagram which he used.

The following were the results arrived at:—

The absolute zero of the perfect gas thermometer is

$$\left.\begin{array}{l} 274^\circ{\cdot}6 \text{ centigrade, or} \\ 494^\circ{\cdot}28 \text{ Fahrenheit,} \end{array}\right\} \text{below the temperature of melting ice.}$$

The coefficient of expansion of a perfect gas, in fractions of its volume at the temperature of melting ice, is consequently,—

$$\text{Per degree of the centigrade scale, } \frac{1}{274{\cdot}6} = 0{\cdot}00364166.$$

$$\text{Per degree of Fahrenheit's scale, } \frac{1}{494{\cdot}28} = 0{\cdot}00202314.$$

The following Gentlemen were duly elected as Ordinary Fellows:—

1. Major EDWARD MADDEN, H.E.I.C.S.
2. Dr JAMES WATSON, of Bath.
3. Lieutenant ROBERT MACLAGAN, Bengal Engineers.

The following Donations to the Library were announced:—

Memorie della Reale Accademia delle Scienze di Torino. Serie 2da. Tomo XII. 4to.—*From the Academy.*

Acta Academiæ Cæsareæ Leopoldino-Carolinæ Naturæ Curiosarum. Vol. XXIII., Pars II. 4to.—*From the Academy.*

Transactions of the Linnæan Society of London. Vol. XXI., Part 1. 4to.

Proceedings of the Linnæan Society of London. Feb. 4, 1851, to March 16, 1852. 8vo.—*From the Society.*

Abhandlungen der Akademie der Wissenschaften zu Berlin. 1850. 4to.—*From the Academy.*

Monday, 17*th January* 1853.

RIGHT REV. BISHOP TERROT, Vice-President, in the Chair.

The following Communications were read:—

1. On a simplification of the Instruments employed in Geographical Astronomy. By Prof. C. Piazzi Smyth.

These instruments include all of that smaller class employed by travellers and navigators in determining latitudes and longitudes, and in making surveys.

At sea, the only instrument which can be employed, is some form of the double-reflection instrument, as the sextant, or rather the reflecting circle; and as this is able to compass all the requirements which may be made of it there, great advantage will result in economy, portability, and despatch, if it can be made also to serve the purposes of a traveller by land.

Hitherto, however, this has been accomplished but very inefficiently; for with all the assistance of artificial reflecting horizons and stands,—generally of a singularly unpractical character,—the reflecting circle is only enabled to measure inclined angles and altitudes within very circumscribed limits.

Any traveller, therefore, who wishes to be prepared for every opportunity for observation, has further to load himself with a theodolite for horizontal angles, with a vertical circle for altitudes between 0° and 10°, and between 60° and 90°; with a transit instrument for transit observations; and with an independent telescope for observations of eclipses, occultations, &c.

The author, however, by employing his particular form of the marine reflecting circle, viz., the Edinburgh reflecting circle,—which is even more efficient and convenient at sea than the ordinary form,—and by placing it on a stand of peculiar construction, converts it at once into an altitude and azimuth instrument of a most simple effective character; capable of being employed as any of the above instruments, and with some practical advantages in facility of observing and reading off.

To this combination, therefore, of the naval circle with a stand for land use, he proposed to give the name of the Edinburgh Universal Instrument, and hoped that it might facilitate and promote the observations of geographical astronomy amongst the explorers in distant lands.

2. On the Mechanical Action of Heat, Section VI.:—A review of the Fundamental Principles of the Mechanical Theory of Heat; with remarks on the Thermic Phenomena of Currents of Elastic Fluids, as illustrating those Principles. By W. J. Macquorn Rankine, Esq.

This section contains four sub-sections, the first three of which constitute a review of the fundamental principles of the Mechanical Theory of Heat, which are investigated by a method different from any that has been hitherto employed; while the fourth contains the application of those principles to the determination of the inferences to be drawn from the recent experiments of Mr Joule and Prof. William Thomson on the thermic phenomena exhibited by currents of air rushing through small openings.

In the *First Sub-Section*, the author abstains not only from assuming any hypothesis respecting the nature of heat, or the constitution of matter, but also from taking into consideration the nature, or even the existence, of any such function as temperature. The theorems and formulæ obtained are simply the necessary consequences of the following

DEFINITION OF EXPANSIVE HEAT :—

Let the term Expansive Heat be used to denote a kind of Physical Energy convertible with, and measurable by, equivalent quantities of Mechanical Power, and augmenting the Expansive Elasticity of matter in which it is present.

The conclusions arrived at are applicable to the mutual transformation, not merely of heat and expansive power, but, *mutatis mutandis*, of any two forms of physical energy, known or unknown, one of which is actual, and the other potential.

Let a body whose volume is V, possess the quantity of heat Q, and let its expansive pressure be P. Let it expand from V to V + d V, so that the total expansive power developed is P d V. Then *the latent heat of expansion* during this operation, or the heat which disappears by being converted into expansive power, is

$$Q \frac{d\,P}{d\,Q} d\,V$$

The excess of this above the actual power developed, viz.—

$$\left(Q \frac{d\,P}{d\,Q} - P \right) d\,V$$

is expended in overcoming cohesive force.

When the total quantity of heat in the body increases by d Q, and its volume by d V, the amount of heat which it must receive is made up of the following parts :—

Heat which remains in the body in its original form, increasing the total heat, ...	$d\,Q$
Heat expended in producing molecular changes, independent of change of volume, ...	$\left(f'.Q + Q \frac{d^2 \int P\,d\,V}{d\,Q^2}\right) d\,Q$
Latent heat of expansion, as before, .	$Q \frac{d\,P}{d\,Q} d\,V$

The entire amount being

$$d\,.\,Q = \left(1 + f'\,.\,Q + Q \frac{d^2 \int P\,d\,V}{d\,Q^2}\right) d\,Q + Q \frac{d\,P}{d\,Q} d\,V$$

If from this be subtracted the power developed, $P\,dV$, there remains the expression of the energy received by the body on the whole; that is, the difference between the energy received and the energy given out, viz.—

$$d\Psi = d\,.\,Q - P\,dV =$$

$$\left(1 + f'\,.\,Q + Q\frac{d^2 \int P\,dV}{dQ^2}\right)dQ + \left(Q\frac{dP}{dQ} - P\right)dV$$

This quantity is a complete differential, its integral being

$$\Delta\,.\,\Psi = \Delta\,.\left(Q + f\,.\,Q + \left(Q\frac{d}{dQ} - 1\right)\int P\,dV\right)$$

When the expansive power $P\,dV$ is wholly expended in moving the particles of the expanding body itself, that motion being ultimately extinguished and converted into heat by friction, the above quantity, $d\Psi$, represents the entire quantity of heat which the body has consumed at the end of the process.

In a machine producing power by the alternate expansion and contraction of a body under the influence of heat, let Q_1 and Q_2 represent the greatest and least quantities of heat possessed by the body. Then, to work to the best advantage, the body must receive heat and convert it into expansive power at the constant heat Q_1, and give out heat by compression at the heat Q_2, when the ratio of the heat converted into power to the total heat expended will be

$$\frac{Q_1 - Q_2}{Q_1}$$

In the *Second Sub-Section*, the author, still abstaining from the use of any hypothesis, investigates such properties of temperature as are deducible from the following

DEFINITION OF EQUAL TEMPERATURES:—

Two portions of matter are said to have Equal Temperatures, when neither tends to communicate heat to the other.

Hence immediately follows a

COROLLARY.

All bodies absolutely destitute of heat have equal temperatures.

The ratio of the real specific heats of two substances being defined to be the ratio of the quantities of heat which equal weights of them possess at equal temperatures, the following *Theorem* is proved:—

The ratio of the Real Specific Heats of any pair of substances is the same at all temperatures.

Symbolically, let τ denote the temperature of a body ; $\varkappa$ the temperature of absolute privation of heat ; $\mathfrak{k}$, a function of the nature, and possibly of the density of the body. Then the quantity of heat in unity of weight may be expressed thus—

$$Q = \mathfrak{k} (\psi . \tau - \psi . \kappa)$$

If this notation be introduced into the expression for the greatest proportion of heat convertible into mechanical power by an expansive engine, it becomes

$$\frac{Q_1 - Q_2}{Q_1} = \frac{\psi . \tau_1 - \psi . \tau_2}{\psi . \tau_1 - \psi . \kappa}$$

that is to say, this ratio is a function merely of the temperatures of receiving heat, τ_1, and of emitting heat, τ_2, and independent of the nature of the body. This is *Carnot's Theorem*, as modified by Messrs Clausius and Thomson. The expression for the latent heat of expansion becomes

$$Q \frac{d\,P}{d\,Q} d\,V = \frac{\psi . \tau - \psi . \kappa}{\psi' . \tau} \cdot \frac{d\,P}{d\,\tau} d\,V$$

$$= \frac{J}{\mu} \cdot \frac{d\,P}{d\,\tau} d\,V, \text{ in Prof. Thomson's notation.}$$

Hence, in Professor Thomson's notation,

$$Q = \mathfrak{k}\, e^{\frac{1}{J} \int \mu\, d\,\tau}$$

which, being introduced into the formulæ of the first sub-section, reproduces all his formulæ.

In the *Third Sub-Section*, the author points out the consequences peculiar to the Hypothesis of Molecular Vortices (that is to say, of whirling eddies in elastic atmospheres surrounding atomic nuclei) ; an hypothesis, the first outline of which was given by Sir Humphry Davy, and which the author adopted, with modifications and additions, as the basis of his investigations in the first five sections of this paper, in two papers on the Centrifugal Theory of Elasticity, and in other papers, with a view to the deduction of the laws of heat and elasticity from the principles of mechanics. After pointing out the resemblances and differences between this hypothesis and that of Molecular Collisions proposed by Messrs Herapath and Waterston, and remarking that the Hypothesis of Molecular Vortices, besides representing successfully the theory of expansive heat, is consistent with that of radiant heat and light, and well adapted to form a basis for that of the elasticity of solids, the author shews, by a method more simple than those formerly employed by him, that, according to this hypothesis, the pressure of a perfect gas is represented by

$$P = (NQ + h)\frac{1}{V}$$

N and h being specific coefficients. Let V_0 be the volume of unity of weight of a perfect gas at a standard pressure P_0, and temperature τ_0; then absolute temperature, as measured by a perfect gas thermometer, has this value—

$$\tau = \tau_0 \frac{P\,V}{P_0\,V_0} = \frac{\tau_0}{P_0\,V_0}\,(NQ + h)$$

The absolute temperature of total privation of heat is

$$\kappa = \frac{\tau_0\,h}{P_0\,V_0}$$

The quantity of heat in unity of weight of a body is

$$Q = \mathfrak{k}\,(\tau - \kappa)$$

where

$$\mathfrak{k} = \frac{P_0\,V_0}{N\,\tau_0}$$

is the coefficient of real specific heat.*

The introduction of this value of heat in terms of temperature into the equations of the first sub-section, reproduces all the formulæ which were deduced directly from the hypothesis in the author's previous researches. In particular, the greatest proportion of heat convertible into mechanical power in an expansive engine working between the temperatures τ_1 and τ_2, is

$$\frac{\tau_1 - \tau_2}{\tau_1 - \kappa}$$

The value of f (Q) is

$$\mathfrak{k}\,N\,\kappa\left(\text{hyp. log}\,\tau + \frac{\kappa}{\tau}\right)$$

In the *Fourth Sub-Section*, the author investigates the inferences to be drawn from the experiments of Messrs Joule and Thomson.

* These conclusions have since been confirmed by M. Regnault's experiments on the Specific Heat of Gases. (See *Comptes Rendus*, 1853, and Philos. Mag., June 1853.)

If a gas in a compressed state be allowed to expand by rushing through small apertures, so that the expansive power developed shall all be converted, first, into tangible motion, and then by friction into heat, while the gas gives out no mechanical power to other bodies, and neither receives nor gives out heat, its condition is expressed by the following equation :—

$$
\begin{aligned}
0=\Delta\,\Psi=\Delta\,.\,&\left\{\mathrm{Q}+f(\mathrm{Q})+\left(\mathrm{Q}\frac{d}{d\mathrm{Q}}-1\right)\int \mathrm{P}\,d\,\mathrm{V}\right\}\\
&=\mathfrak{k}\,\Delta\,\tau+\Delta\int\left(\tau\frac{d\,\mathrm{P}}{d\,\tau}\;-\right)d\,\mathrm{V}\\
&\quad-\kappa\left\{\Delta\int\frac{d\,\mathrm{P}}{d\,\tau}\,d\,\mathrm{V}-\mathfrak{k}\,\mathrm{N}\left(\Delta\,.\frac{\kappa}{\tau}+\Delta\,\text{hyp. log}\,\tau\right)\right\}
\end{aligned}
$$

The cooling effect of a given expansion in atmospheric air, $-\Delta\tau$, has been the subject of experiment. The term

$$\Delta\int\left(\tau\frac{d\,\mathrm{P}}{d\,\tau}-\mathrm{P}\right)d\,\mathrm{V}$$

which represents the heat expended in overcoming molecular attraction, is calculated by means of formulæ deduced by the author from M. Regnault's experiments, with the aid of the hypothesis, as well as the function by which κ is multiplied. Thus each series of experiments supplies data for computing an approximate value of κ, the absolute temperature of total privation of heat. The values of κ thus calculated from ten series of experiments, range from 1°·08 to 2°·345 centigrade. The greatest discrepancy is therefore 1°·265 centigrade, which would cause a maximum error of only one three-hundredth part in calculating the power of any expansive engine. The values of κ are both largest, and agree best together, for those experiments in which the quantity of air used was greatest, and therefore the risk of error least. The author considers that the experiments prove the formulæ deduced from the Hypothesis of Molecular Vortices to be at least sufficiently correct for practical purposes ; that they afford a strong probability of the theoretical soundness of the hypothesis ; and that the position of the *absolute zero of heat* is nearly as follows :—

	Centigrade.	Fahren.
Above absolute zero of a perfect gas thermometer, .	2°·1	3°·78
Below the temperature of melting ice, . . .	272°·5	490°·5

The paper concludes with formulæ for future use in reducing experiments on Carbonic Acid Gas.

The following Donations to the Library were announced :—

Flora Batava. Part 171. 4to.—*From the King of Holland.*

The Assurance Magazine, and Journal of the Institute of Actuaries. No. 10. 8vo.—*From the Institute.*

Journal of the Horticultural Society of London. Vol. VII., Part 4; Vol. VIII., Part 1. 8vo.—*From the Society.*

Mémoires de l'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique. Tom. XXVI. 4to.

Mémoires Couronnés et Mémoires des Savants Etrangers, publiés par l'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique. Tome XXIV. 4to.

Bulletins de l'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique. Tomes XVII.–XIX. (1850–1852.) 8vo.

Annuaire de l'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique. Tomes XVII.–XIX. (1851 and 1852.) 12°.

Mémoires Couronnés et Memoires des Savants Etrangers, publiés par l'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique. Collection in 8°. Tome V.—*From the Academy.*

Annales de l'Observatoire Royal de Bruxelles, publiées aux frais de l'Etablissement, par le Directeur, A. Quételet. Tomes VIII. et IX. 4to.

Annuaire de l'Observatoire Royal de Bruxelles, par A. Quételet. 1851 & 1852. 12°.—*From the Editor.*

Résumé des Observations sur la Météorologie et sur le Magnetisme Terrestre faites à l'Observatoire Royal de Bruxelles en 1850, et communiquées par le Directeur, A. Quételet. 4to.—*From the Author.*

The Canadian Journal; a Repertory of Industry, Science, and Art, and a Record of the Proceedings of the Canadian Institute. October and December 1852. 4to.—*From the Institute.*

Journal of the Royal Geographical Society of London. Vol. XXII. 1852. 8vo.—*From the Society.*

Catalogue Méthodique de la Collection des Reptiles. Muséum d'Histoire Naturelle de Paris. 8vo. Catalogue Méthodique de la Collection des Mammifères de la Collection des Oiseaux.

Muséum d'Histoire Naturelle de Paris. 8vo.—*From the Museum.*

Berichte über die Verhandlungen der Königlich Sachsischen Gesellschaft der Wissenschaften zu Leipzig. (1848.) 8vo. Bande I., II., III.—*From the Society.*

Catalogue des Manuscrits et Hylographes Orientaux de la Bibliothèque Impériale Publique de St Pétersbourg. 8vo.—*From the Russian Government.*

Monday, 7th February 1853.

DR CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. On the Structural Characters of Rocks. By Dr Fleming.

While the condition of the mineral masses in the neighbourhood of Edinburgh furnish interesting illustrations of the structural characters of rocks, such as the columnar, the concretionary, and the fragmentary, &c., the author proposed to confine his remarks at present to what he denominated the FLAWED STRUCTURE.

In the ordinary language of quarriers, the *flaws* are termed *backs*, while they are known to masons as *dries*, and to geologists, when referred to, as *slicken-sides*. This last term, independent of its provincial character, refers to one peculiar form of the flaw only, and, although explicable according to the same views entertained respecting the origin of the others, is far from being a typical form. The *flaw* of the lapidary, in reference to crystals or gems, comes sufficiently near in character to justify its adoption.

The FLAW is a crack which is confined to the stratum or bed in which it occurs, and is thus distinguished from *fault* or dislocation, since these extend through several beds. It occupies all positions in the bed, without an approach to parallelism, the flaws being variously inclined to one another, and not extending continuously throughout the thickness of the bed; thus differing from the *columnar structure.*

These flaws are sometimes isolated; in other cases two unite at angles more or less acute, and the junction edges are either sharp or rounded. The surface of the sides of the flaw is frequently crumpled or waved, and in the granularly-constituted beds, such as granite, porphyry, or sandstone, is rough, while in slate-clay, bituminous shale, and steatite, it often exhibits a specular polish.

The circumstance of the flaws exhibiting no approach to parallelism, joined to the fact that they are not prolonged into the inferior or superior beds, nay, frequently not extending throughout the bed containing them, furnish a demonstration that they were not produced by an external force. The notion, too, is untenable, that the polishing was produced by the faces of the flaw sliding backwards and forwards on one another, because their limited extent, mode of junction, and waved surfaces clearly indicate the absence of any such alternate shifting.

The author then stated his opinion that the flaws had been produced by *shrinkage*, owing to the escape of volatile matter, aided by molecular aggregation, and that the polished surfaces were produced in comparatively soft plastic matter, like bituminous shale, by the presence of water or gas in the cavity, so that the specular character was the *casting* or impression of a liquid surface. The empty vesicles of amygdaloid are occasionally found glossy on the walls, or exhibiting an apparently vitrified film, while the rock itself is dull and earthy in fracture. The smoothness in this instance is probably produced as the casting or impress of included vapour or gas. Sometimes the flaws in coarse materials, such as porphyry, have a specular aspect, owing to a film of anhydrous peroxide of iron. Illustrative examples were exhibited, and references to various localities around Edinburgh, where the whole phenomena of *flawed* structure were well displayed.

2. Observations on the Speculations of the late Dr Brown, and of other recent Metaphysicians, regarding the exercise of the Senses. By Dr Alison.

The object of this paper was to recal attention to the celebrated controversies on this subject, carried on during the last century; chiefly because some expressions used by Dr Brown, by Lord Jeffrey, Sir James Mackintosh, and M. Morell, convey the impression that the doctrines of Reid and Stewart on this essential part of their system of Metaphysics, are now generally neglected or abandoned.

The author endeavoured to shew, on the contrary, that the existence and authority of what Reid called Principles of Common Sense, and Stewart called Fundamental Laws of Belief, and Brown called Principles acquired by Intuition, as *ultimate facts* in the constitution of the human Mind; and farther, the necessity of reference to such principles, in any account that can be given of the information acquired by the Senses,—is admitted by all those authors, and must be regarded as an established first principle in this science. He stated that the only real addition made to our knowledge of this subject by Dr Brown, consisted in his pointing out the province of the *muscular sensations,* as distinguished from those produced by impressions on the *cutaneous nerves,* in suggesting to us the notions of the Primary qualities of Matter; and that his doctrine as to the manner in which the idea of external independent existence is suggested to the mind, is substantially the same as that previously proposed by Turgot, and adopted by Stewart, and strictly consistent with the statements of Reid.

He maintained farther, that when Dr Brown and other more recent authors, supposed that they had detected an error in the reasonings of Reid and Stewart against the scepticism of Berkeley and Hume, they had deceived themselves; *first,* Because they stated the object of Reid to be, to prove, by *argument,* the independent existence of the material world, which he had expressly disclaimed; *secondly,* Because they stated the substance of the sceptical argument to be merely the *negative* proposition, that that independent existence cannot be proved by reasoning; whereas it was the *positive* proposition, that the idea of such independent existence involves an absurdity, or contradiction in terms; and, *thirdly,* Because they entirely overlooked *the fact,* on which Reid and Stewart relied, as evidence that the Perceptions, or notions which the mind forms of the qualities of external objects, can be referred only to those fundamental Laws of Belief, which *all admit* as ultimate facts in this department of science:—viz., the *utter dissimilarity* of these Perceptions to the Sensations which introduce them into the mind; from which they argued, not that the objects of Perception have been proved to exist by reasoning, but that there is no more absurdity, or contradiction in terms, in believing that they exist, than in believing in our own identity, or in the suggestions of Memory.

Lastly, the author maintained, that when Reid's doctrine of Perceptions, as distinct from Sensations, is duly reflected on, it will be found to involve all the theological inferences, which Morell and others have supposed to be suggested only by the view of this subject which has been taken by some German metaphysicians; and to be remarkably in accordance with all that has been recently ascertained in regard to the connection of the different Mental acts with the living action of different parts of the Nervous System; and farther, to be quite compatible with the supposition (the evidence of which he considered as still *sub judice*) of Perception taking place, even in this state of human existence, otherwise than by the ordinary exercise of the Senses.

The following Gentlemen were duly elected as Ordinary Fellows:—

1. The Rev. Dr Robert Lee, Professor of Biblical Criticism.
2. J. S. Blackie, Esq., Professor of Greek.
3. The Right Rev. Dr Trower, Bishop of Glasgow, and late Fellow of Oriel College.

The following Donations to the Library were announced:—

Craigie's Practice of Physic. 2 vols. 8vo.—*From the Author.*

Abhandlungen der Akademie der Wissenschaften zu Berlin. 1850 & 1851. 4to.

Monatsbericht der Akademie der Wissenschaften zu Berlin. Juli–Oct. 8vo.—*From the Academy.*

Acta Academiæ Cæsareæ Leopoldino-Carolinæ Naturæ Curiosarum. Vol. XXII., Suppl., and XXIII. 4to.—*From the Academy.*

Memorias della Real Accademia de Ciencias de Madrid. Tome I., Part 2. Fol.

Resumen de las Actas della Accademia Real de Ciencias de Madrid. 1850 and 1851. 8vo.—*From the Academy.*

Monday, 21*st February* 1853.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following Communication was read :—

On the Summation of a Compound Series, and its application to a Problem in Probabilities. By the Right Rev. Bishop Terrot.

The series proposed for summation is

$$\begin{array}{lll} & \overline{m-q}\,.\,\overline{m-q-1}\ldots m-\overline{q+p+1} & \times\, 1\,.\,2\,.\,3\ldots q \\ + & \overline{m-q-1}\,.\,\overline{m-q-2}\ldots\ldots m-\overline{q+p} & \times\, 2\,.\,3\,.\,4\ldots q+1 \\ & \quad\vdots & \quad\vdots \\ + & p\,.\,p-1\,.\,p-2\ldots\ldots\ldots 1 & \times\,\overline{m-p}\,.\,\overline{m-p+1}\ldots m-\overline{p+q}+1 \end{array}$$

In which series each line or term is the product of two factorials, the first consisting of p, the last of q factors of successive numbers. And in each successive term the factors of the first factorial are diminished each by unity, and the factors of the last increased.

The method employed to sum this series is to multiply the sum of all the left-hand factors into the first right-hand factor; the sum of all except the first, into the difference between the first and second of the right-hand factors, and so on; thus reducing the series to the form

$$\frac{q}{p+1}\times(\overline{m-q+1}\,.\,\overline{m-q}\ldots\ldots\ldots m-\overline{p+q}+1)\times 1\,.\,2\,.\,3\ldots q-1$$

$$+\frac{q}{p+1}(\overline{m-q}\,.\,\overline{m-q-1}\ldots\ldots\ldots m-\overline{p+q})\times 2\,.\,3\ldots\ldots\ldots q$$

&c. &c. &c.

If this integration on the one side and differentiation on the other be continued for q times, the series is reduced to the single term

$$\frac{q\,.\,q-1\,.\,q-2\ldots\ldots 1}{p+1\,.\,p+2\ldots\ldots p+q+1}\times m+1\,.\,m\ldots\ldots\ldots m-\overline{q+p}+1.$$

This summation is applicable to the solution of the problem, Suppose an experiment concerning whose inherent probability of success we know nothing, has been made $\overline{p+q}$ times, and has succeeded

p times and failed q times; what is the probability of success at the $\overline{p+q+1}^{|\text{th}}$ trial?

This problem gives four varieties, according as m, the possible number of experiments, is finite or infinite, and according as results effected can or cannot be repeated. If we take the common example of drawing balls, which must be either black or white, from a bag, then results effected may be repeated if the balls are replaced after being drawn; if the balls drawn are not replaced, then the same result cannot be repeated. The only case of the problem which the author of this paper has been able to find solved in any treatise on probabilities, though he must confess that his range of inquiry has not been very large, is that where m is infinite, and the balls drawn are replaced. His object in his paper was to solve the case where m is finite, and the balls are not replaced.

In this case it is manifest that the number of white balls contained in the bag may be any number from $\overline{m-q}$ to p, and the corresponding number of black, any number from q to $\overline{m-p}$. Then, omitting the common constants, the several hypotheses which can be formed as to the proportion of black and white balls in the bag at first, H_1, H_2, H_3, &c., give, for the probability of the event observed, that is, for the drawing of p white and q black balls, the following probabilities:—

$$H_1,\ \overline{m-q}\,.\,\overline{m-q-1}\ldots\ldots\overline{m-q-p+1}\times 1\,.\,2\,.\,3\cdots\cdots q \qquad (\alpha)$$

$$H_2,\ \overline{m-q-1}\,.\,\overline{m-q-2}\cdots\cdots\overline{m-q-p}\times 2\,.\,3\,.\,4\cdots\cdots q+1 \qquad (\beta)$$

and so on for all the other hypotheses. Hence the probability of H_1, which is $\dfrac{\alpha}{\alpha+\beta+\gamma}$ &c. $=$ (by the preceding summation)

$$\frac{p+1\,.\,p+2\cdots\cdots\cdots p+q+1}{m+1\,.\,m\cdots\cdots\cdots m-p-q+1\times 1\,.\,2\,.\,3\cdots\cdots q}\times$$
$$\overline{m-q}\,.\,\overline{m-q-1}\cdots\cdots m-q-p+1\times 1\,.\,2\cdots\cdots q.$$

Therefore the probability of a white ball at $\overline{p+q+1}^{|\text{th}}$ drawing, derived from H_1, is

$$\frac{p+1\,.\,p+2\cdots\cdots\cdots p+q+1}{(m+1\,.\,m\cdots\cdots\cdots m-p-q+1)\times 1\,.\,2\,.\,3\cdots\cdots q}\times$$
$$m-q\,.\,m-q-1\cdots\cdots m-q-p\times 1\,.\,2\,.\,3\cdots\cdots\cdots q.$$

In same way the probability derived from H_2 is the same fraction into

$$(m-q-1\,.\,m-q-2\cdots\cdots m-q-p-1)\times 2\,.\,3\cdots\cdots q+1$$

and so for all the other hypotheses. And summing again this series, we have the whole probability equal—

$$\frac{p+1\,.\,p+2\cdots p+q+1}{(m+1\,.\,m\cdots m-p-q)\times 1\,.\,2\cdots q}\times\frac{1\,.\,2\cdots\cdots q}{p+2\,.\,p+3\cdots p+q+2}\times$$
$$m+1\,.\,m\cdots\cdots\cdots m-p-q=\frac{p+1}{p+q+2}$$

As this expression does not involve m, it follows that when the balls drawn are not replaced, the probability of drawing a white ball at the $\overline{p+q+1}|^{\text{th}}$ trial, depends entirely upon p and q, and is unaffected by the magnitude of m, whether finite or infinite.

The last portion of the paper considers the case where m is given, and the balls drawn are replaced.

It is evident that in this case the main point must be to sum the series

$$\overline{m-1}|^{p}\times 1^{q}+\overline{m-2}|^{p}\,.\,2^{q}\cdots\cdots 1^{p}\,.\,\overline{m-1}|^{q}$$

This was effected by a process similar to that used in the last case, and the sum found to be

$$\Sigma_q\,\overline{m-1}|^{p}+d_2\,\Sigma_q\,\overline{m-2}|^{p}\cdots\cdots\cdots d_{q+1}\,\overline{m-q}|^{p}$$

Where $\Sigma_q\,\overline{m-1}|^{p}$ means the q^{th} integration of the series

$$1+2^{p}\cdots\cdots\overline{m+1}|^{p},$$

and d_1, d_2, d_3, &c., mean the 1st, 2d, 3d terms of the q^{th} row of differences of the series $1_q\,.\,2^q$, &c.

Applying this as was done with the $\alpha+\beta+\gamma$, &c., of the last case, the probability of a white at the $\overline{p+q+1}|^{\text{th}}$ drawing is

$$\frac{\Sigma_{q+1}\,\overline{m-1}|_{p+1}+d_2\,\Sigma_{q+1}\,\overline{m-2}|^{p+1}\cdots\cdots d_q\,\Sigma_{q+1}\,\overline{m-q}|^{p+1}}{m\left(\Sigma^{q}\,\overline{m-1}|^{p}+d_2\,\Sigma_q\,\overline{m-2}|^{p}\cdots\cdots d_q\,\Sigma_{q+1}\,\overline{m-q}|^{p}\right)}$$

If m be infinite, this becomes $\dfrac{\Sigma_{q+1}\,m^{p+1}}{m\,\Sigma^{q+1}\,mp}=\dfrac{p+1}{p+q+2}$

The following Gentlemen were duly elected as Ordinary Fellows:—

1. JAMES M. HOG, Esq. of Newliston.
2. The Rev. JOHN CUMMING, D.D.

Monday, 7th March 1853.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read:—

1. On the Species of Fossil Diatomaceæ found in the Infusorial Earth of Mull. By Professor Gregory.

The author, after some general remarks on the Infusoria generally, and especially on their occurrence in the fossil state, mentioned that the earth in question had been discovered by the Duke of Argyll at Knock, near Aros in Mull, and its geological position briefly described by him to the Society, two years ago. The author had undertaken an examination of it, and had found it to contain, besides Phytolitharia, silicified pollen of grasses and coniferæ, and spicules and gemmules of fresh-water sponges, the unprecedented number of about 60 species of Diatomaceæ. He had consulted the Rev. W. Smith, who had observed in it the following 59 species, all belonging to fresh water, which he named, the names being those of his forthcoming Synopsis, and one species which he cannot at present refer to any known form.

1. Pinnularia......major.
2. „ ......viridis.
3. „ ......oblonga.
4. „ ......divergens.
5. „ ......radiosa.
6. „ ......interrupta.
7. „ ......gibba.
8. „ ......Tabellaria.
9. „ ......gracilis.
10. „ ......acuta.
11. „ ......mæsolepta.
12. „ ... ..gracilis.
13. „ ......lata.
14. „ ......alpina.
15. Navicula.........rhomboides.
16. „ ....serians.
17. „ ....dicephala.
18. „ ....firma.
19. „ .. ..angusta.
20. „ ....ovalis.
21. Gomphonema...acuminatum.
22. „ ...*d.* var. β coronatum.
23. Gomphonema Vibrio.
24. „ ...capitatum.
25. Amphora ......ovalis.
26. Stauroneis.....Phœnicenteron.
27. „ ......gracilis.
28. „ ......anceps.
29. „ ......linearis.
30. Cocconeis......Thwaitesii.
31. „ ......Placentula.
32. Surirella ......biseriata.
33. „ ......Brightwellii.
34. Cymbella......Helvetica.
35. „ ......Scotica.
36. „ ......maculata.
37. „ ......affinis.
38. „ ......cuspidata.
39. Cymatopleura elliptica.
40. „ apiculata.
41. Himantidium gracile, *Kütz.*
42. „ Arcus, *Kütz.*
43. „ majus, *W. Sm.*
44. „ pectinale, *Kütz.*

45. Himantidium undulatum, *Ralfs.*
46. „ bidens, *W. Sm.*
47. Tabellaria ......fenestrata, *Kütz.*
48. „ ......ventricosa, *Kütz.*
49. Epithemia......turgida.
50. „ ......gibba.
51. Eunotia.........gracilis.
52. „ ....tetraodon.
53. Eunotia.........Diadema.
54. Synedra........capitata.
55. „ ....biceps.
56. Fragillaria....capucina, *Kütz.*
57. Orthoseira.....orichalcea, *W. Sm.*
58. „ .....nivalis, *W. Sm.*
59. Nitzschia......sigmoidea, *W. Sm.*

The 60th is the unknown or doubtful species, which is from $\frac{1}{600}$ to $\frac{1}{470}$ of an inch long, and has 44 cross striæ in $\frac{1}{1000}$ of an inch. In has generally the form nearly of a narrow plano-convex lens, with two notches near the ends of the plane side. It seems to approach Eunotia arcus (*Kützing*), but requires further investigation. In the mean time, Mr Smith proposes to call it Eunotia incisa.

The Mull earth is characterised by the great abundance of Pinnulariæ, Naviculæ, and Stauroneides; by that of Gomphonema coronatum, of the Cymbellæ, of the Himantidia, Eunotiæ, and Epithemiæ, of Tabellariæ, and of Eunotia incisa.

Its chemical analysis yielded

Silica, ...	70·75
Protoxide of iron, with traces of manganese, and an appreciable amount of phosphoric acid,	15·04
Organic matter, ...	12·36
Water and loss, ...	1·85
	100·00

Its composition renders it probable that it may be useful as a manure. It may also be made to yield an excellent polishing powder.

This earth occurs in a hollow, formerly a small loch in winter and a pool in summer, now drained, lying in a rough piece of ground, a mile or a mile-and-a-half in extent, between Loch Baa and the sea, and about 30 or 40 feet above the sea-level. It rests on gravel, and the gravel rests immediately on the granite of the district. It is impossible to fix precisely the age of the deposit, but, from the species it contains, it is probable that it is not of very recent origin; while yet its epoch must be supposed subsequent to that of the deposition of the gravel in which it is found.

Specimens of the earth, and drawings of a number of the species were exhibited; also specimens of polishing powder made from the earth.

2. On the Production of Crystalline Structure in Crystallised Powders, by Compression and Traction. By Sir David Brewster, K.H., D.C.L., F.R.S., V.P.R.S. Edin.

The author, after alluding to the influence of compression and dilatation in producing the doubly refracting structure in solids of all kinds devoid of it, and in modifying it where it exists, mentioned that the phenomena to be described have no relation to those alluded to.

In experimenting on the *double reflexion* and polarization of light discovered by him in the chrysammates of potash, and magnesia, murexide, and other crystals, he found that they could be spread out on glass by hard pressure, like grease or soft wax; and that in the case of dark powders, he could thus obtain a transparent film, exhibiting double reflexion and polarization from its surface, as well as if it had been a large crystal.

In studying these phenomena under polarized light, he found that the streaks and lines had axes of double refraction, as well as the film composed of them, just as if they were regular crystals. When the substance possessed the new property in perfection, these lines, though very minute, were not formed of insulated particles dragged into a line, but the lines of polarized light were continuous, and the crystallographic as well as the optical axis of the particles, were placed in that line. In other cases, the insulation of the particles was easily seen.

The substance may be subjected to pressure and traction, either on smooth or on ground glass, the latter being preferable for hard substances. A polished and elastic knife is used to give the pressure. The lines thus formed, examined in the polariscope, exhibit regular neutral and depolarizing axes. With the chrysammate of magnesia, the appearances are peculiarly splendid; its natural colours, which vary with the thickness, being combined with the tints depolarized by the streaks. As these crystals are dichroitic, and possess unusual reflexion, so also the streaks exhibit the same; the two pencils being carmine red and pale yellow.

This property the author has found more or less in the following crystals :—

Chrysammate of magnesia.
... potash.
Hydro-chrysammide.
Murexide.
Aloetinate of potash.
Aloetinic acid.

Oxamide.
Palmine.
Palmic acid.
Amygdaline.
Tannin, pure.
Quinine, pure.
  ... acetate of.
  ... sulphate of.
  ... muriate of.
  ... phosphate of.
  ... citrate of.
Cacao butter.
Veratric acid.
Esculine.
Theine.
Silver, cyanide of.
  ... acetate of.
Platinum & magnesium, cyanide of.
  .. and barium, cyanide of.
  ... and potassium, cyanide of.
  ... ammonia, chloride of.
Potash, chlorate of.
  ... chromate of.
Urea, nitrate of.
Sulphur.
Camphor.
Cinchonine.
Cinchonine, sulphate of.
Meconic acid.
Brucine, sulphate of.
Morphia, acetate of.
Tin, iodide of.
Cerium, oxide of.
Parmeline.
Lecanorine.
Indigo, red.
Ammonia, oxalate of.
  ... sulphate of.
Soda, chromate of.
Lead, iodide of.
Strychnine, sulphate of.
  ... acetate of.
Soda, nitrate of, native.
Berberine.
Mucic acid.
Solanine.
Asparagine.
Mercury, bichloride of.
Isatine.
Alizarine.
Manganese, sesquioxide of.
Lead, protoxide of.
Tungstic acid.
Oxalate of chromium and potash.

In many substances, when subjected to pressure and traction, the particles exhibit no such arrangement into transparent streaks, as in the above, but are merely dragged into lines, and exhibit a quaquaversus polarization. But there is another class, which yields transparent streaks, without any trace of prismatic arrangement. Such are the bodies in the following list :—

Hydrate of potash, pure.
Indigotic acid.
Urea.
Citric acid.
Silver, nitrate of.
Meconine.
Napthaline.
Soda, nitrate of, pure.
Potash and copper, sulphate of.
Soda, phosphate of.
Soda, acetate of.
Mercury, cyanide of.
  ... chloride of.
  ... sulphuret of.
Baryta, acetate of.
Zinc, chromate of.
  ... sulphate, of.
Cobalt, sulphate of.
Magnesia and soda, sulphate of.
Borax.

Compression is, no doubt, the agent which forces the particles into optical contact, and traction draws them into a line, tending to separate them in that direction. These forces may possibly modify the doubly-refracting structure, but the author has not examined this question.

On trying certain soft solids which possess double refraction, such as bees' wax, oil of mace, almond soap, and tallow, remarkable results were obtained. Almond soap, the particles of which are not in optical contact, may be drawn out into strings, and these strings possess neutral and depolarizing axes like the streaks above described. This is done by traction alone. Similar results are obtained in oil of mace and tallow, by compression and traction. In bees' wax, the depolarizing lines are even better displayed, especially if a little common resin be added.

It is not easy to explain why, in these experiments, the optical and crystallographic axes of the particles are placed in the same line. Mechanical force is the primary agent, but it is possible that electricity may also contribute, even in the case of almond soap, to the result. In that case, however, by drawing it out into a thread, we diminish all the lateral obstacles to a crystalline arrangement. Elementary prisms, or crystals whose length much exceeds their breadth, will then tend to place their long axes in the line of traction, and as the lateral obstructions are removed, the particles may follow their natural tendency.

We have reason to suppose, that in hard substances the same principle acts, and that the particles, when drawn into narrow lines and freed from lateral attractions, may more readily assume the crystalline arrangement which is natural to them, and is the result of certain inherent polarities.

In some cases, where the crystalline arrangement was imperfectly produced, the author observed a tendency in the particles to quit their position, as if they were in a state of unnatural tension or restraint. This probably depends on the non-homologous sides of the elementary particles having been brought into contact, a condition quite compatible with the existence of neutral and depolarizing axes, provided the non-homologous sides deviate from their proper position either 90° or 180°. In that case, polarized light, directly transmitted, will exhibit the same colours as if the sides were in the normal position. But if transmitted obliquely, the hemitropism of the combination, as we may call it, will be at once detected by the difference in colour of the two plates.

3. On the Structure and Economy of Tethea, and on an undescribed species from the Spitzbergen Seas. By Professor Goodsir.

The author, after a brief summary of the observations of Donati, M. Edwards, Forbes, Johnston, and Huxley, on various species of Tethea, described the structure, and deduced the probable economy of a large species apparently undescribed, some specimens of which he had procured from the Spitzbergen Seas.

The following peculiarities of form and structure were minutely detailed and illustrated:—

1. The turbinated form of the sponge.

2. The partial distribution of the rind.

3. The minute pores of the rind, arranged in threes; a pore in each of the angles, formed by the primary branches of the six-radiate spicula.

4. The water, instead of passing out by oscula, drains through a perforated or net-work membrane which lines a number of irregularly tortuous grooves on the surface of the attached hemisphere of the sponge,—the grooves being continuous with deep fissures, which extend into the rind, and are apparently the result of distension from internal growth.

5. The silicious spicula are arranged according to the type of the skeleton in the other Tetheæ. Elongated, slightly bent or twisted rod-like spicula, are combined in bundles by means of fibrous substance, and a few boomerang-shaped spicula, laid crossways. These bundles are arranged irregularly in the centre of the sponge, so as to form a nucleus from which radiating masses extend outwards to the rind, or beyond the surface, where the rind is deficient. The spicula of the rind are large and six-radiate. Their shafts are deeply and firmly inserted into the radiating bundles. Their three primary branches are set at angles of 120° to the shaft, and to one another. The two secondary branches at the extremity of each primary branch are long-pointed, slightly concave towards the centre of the sponge, and set at an angle of 90° to one another.

6. The fleshy mass which envelopes the spicular bundles in the interior of the sponge, consists of—1. Ordinary sponge particles; 2. Caudate particles, probably similar to the spermatozoa described and figured by Mr Huxley in an Australian Tethea; 3. Ova-like masses,

the largest of which envelope a radiating arrangement of anchor-like spicula; 4. Towards, and in the rind, elongated cellules, apparently fibrous and muscular, the fibrous connecting the spicula, and with the nucleated muscular cellules arranged transversely as figured by Donati.

7. From the structure of Tethea, as well as from the observations of Donati and M. Edwards, this group of sponges would appear to possess considerable contractility.

The following Donations to the Library were announced:—

Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. N.S. No. 40. 8vo.—*From the Society.*

Papers and Proceedings of the Royal Society of Van Diemen's Land. Vol. II., Part 1. 8vo.—*From the Society.*

The Canadian Journal; a Repertory of Industry, Science and Art, and a Record of the Proceedings of the Canadian Institute. January 1853. 4to.—*From the Institute.*

Flora Batava. 172 Aflevering. 4to.—*From the King of Holland.*

Acta Regiæ Societatis Scientiarum Upsaliensis. 3d Series. Vol. I. Fascic. 1. 4to.—*From the Society.*

Berichte über die Verhandlungen der Königlich Sächsischen Gesellschaft der Wissenschaften zu Leipzig. Mathematisch-Physische Classe I. 8vo.—*From the Society.*

Ueber Musikalische Tonbestimmung und Temperatur. Von M. W. Drobisch. 8vo.—*From the Author.*

Beiträge zur Kenntnis der Gefäss-kryptogamen. Von Wilhelm Hofmeister. 8vo.—*From the Author.*

Jahrbuch der Kaiserlich-Königlichen Geologischen Reichsanstalt. 1852. No. 2. 8vo.—*From the Institute.*

Memoirs of the American Academy of Arts and Sciences. N.S. Vol. IV., Part 2. 4to.—*From the Academy.*

Monday, 21*st March* 1853.

RIGHT REV. BISHOP TERROT, Vice-President, in the Chair.

The following Communication was read:—

On Circular Crystals. By Sir David Brewster K.H.,D.C.L., F.R.S., V.P.R.S.E, Associate of the Institute of France.

The author, after mentioning Mr Fox Talbot's observation, in 1836, of circular crystals from a solution of borax in phosphoric acid, stated, that about twenty years before Mr Talbot's paper was published, he had obtained circular crystals from oil of mace, and from a mixture of that oil with tallow or rosin. These circular crystals are groups of radiating prisms, in optical contact, so as to appear like individual crystals. Viewed by polarized light, they exhibit four luminous sectors, separated by a rectangular black cross, which often has its arms so divergent, as to form four dark sectors. The arms of the cross are parallel and perpendicular to the plane of primitive polarization. When a bright disc of ordinary light was looked at through these circular spots, there was seen a halo, or two halos, produced by the crystals of the oil of mace. In the case of two halos, polarized light shewed two sets of four luminous sectors, as far apart as the halos. The halos were, in fact, double, being the two images produced by the double refraction of the elementary crystals. In pursuing the inquiry, the author found that the phenomena were caused by circular crystals or groups, varying from invisibility to the $\frac{1}{200}$th or $\frac{1}{300}$th of an inch in diameter, and when of this size, exhibiting beautiful luminous sectors in polarized light. Circular crystals are easily distinguished from those which exhibit true quaquaversus polarization, by using a plate of selenite, which, with the circular crystals, produces spots or sectors of two different colours, one a little lower, the other a little higher than the tint of the selenite.

He next examined a number of substances which yield circular crystals, particularly the lithoxanthate of ammonia (a salt formed by the action of ammonia on xanthic oxide), which yields them with more facility and certainty than borax. Out of more than 300 substances, he found upwards of 70 which yielded circular crystals, about thirty being positive, like zircon, and forty negative, like calcareous spar. The phenomena observed are most splendid, and open up a wide field of research.

The author next detailed, and illustrated with minute and carefully coloured drawings, these phenomena, as observed in the following substances, the most remarkable of the whole number.

1. *Lithoxanthate of Ammonia.*—Here, in the usual specimens, the light polarized by the sectors is the blue of the first order, often the white and the yellow of the same order. In separate circular crystals, other appearances occur. In one, the three first orders of colours appeared exactly as in the coloured rings of uniaxial crystals, proving that the elementary prisms or radii must have increased in thickness from the centre outwards, according to Newton's law of periodical colours. In others, the second and third bands were of different but uniform colours throughout, proving uniform thickness all round in each band. These colours were generally red and green, not at all related to the central tint, or to one another. In some cases, the order of colours is inverted. In the most perfect crystals, the central tints are the blue and white of the first order, in consequence of the great minuteness of the elementary crystals, which form a more uniform disc, with an exceedingly sharp black cross. This central part is surrounded by a narrow black ring, beyond which is an annulus of sectors, sometimes white, like the inner ones. This is terminated by a black circle, beyond which is a third series of sectors, either white or blue of the first order. The black cross starts into greater breadth as it passes from one annulus to the other, from the inferior degree of optical contact in the outer rings. Various other singular modifications occur in this salt, which cannot be detailed here. In some cases, there are large radiant prisms, all polarizing a golden yellow, and the black cross becomes hardly visible. In others, its divergence is so great, that the yellow sectors assume the appearance of a cross.

In some still more complex crystals, there is seen one or more narrow black rings, which arise from the absence of matter where they appear.

2. *Salicine.*—This substance yields splendid discs. When of the diameter of $\frac{1}{30}$th to $\frac{1}{5}$th of an inch, these tints are of the first and second orders, and they form objects of singular splendour. Here also, the smaller crystals polarize a bluish white. The discs of salicine

are composed of prisms varying in thickness, and, of course, in tint, and have often rims, formed of one or two concentric bands, made up of radiant bunches, proceeding from the inner margin of the bands, and not from the centre of the discs. The large discs exhibit ten, twelve, or more fine concentric lines, which are lines of cleavage. Sometimes the rim is as wide as the inclosed part, and these polarize a bluish white.

3. *Asparagine.*—This substance yields discs resembling those of salicine, but are still more brilliant and beautiful. There are some discs which exhibit no circular polarization, and others which exhibit a succession of black and white narrow rings, like those seen round the star Capella, with annular apertures.

4. *Manna.*—This gives fine negative crystals, both by fusion and solution. There is great brilliancy and uniformity of the tints, and the black cross is so sharp that its intersection is not easily seen. The discs form a united hexagonal mosaic, and have no rims.

5. *Disulphate of Mercury.*—The solution of this salt in nitric acid, gives, by slow cooling, square crystals with circular polarization, which undergo singular modifications, for which we must refer to the paper.

6. *Parmeline*, from alcohol, gives fine circular crystals.

7. *Palmic Acid*, by fusion, gives fine negative circular crystals, like the mosaic of manna.

8. *Nitrate of Uranium* gives fine negative circular crystals, from water, alcohol, ether, and oil.

9. *Palmine* gives very minute circular crystals.

10. *Chromic Acid* gives very peculiar circular crystals, composed of concentric rippled bands, generally of the blue of the first order.

11. *Berberine* gives negative circular discs, resembling those of oil of mace.

12. *Sulphuret of Cadmium*, dissolved in nitric acid, that is, nitrate of cadmium, gives beautiful negative circular crystals.

13. *Sulphate of Ammonia and Magnesia.*—This salt yields fine positive circular crystals.

14. *Hatchetine*, *Cacao Butter*, *White Wax*, *Tallow*, *Adipocire*, and all *Soaps*, and different kinds of *Fat*, give circular crystals like oil of mace.

15. *Borax in Phosphoric Acid.*—This salt yielded the circular crystals described by Mr Talbot. This salt, as well as nitrate of uranium, yields hemispherical bells, under certain circumstances, which

polarize light by refraction, and exhibit the black cross, with rings of green and red alternately. The author observed these bells to be formed of minute crystals, radiating from the apex of the bell.

16. *Mannite.*—This substance the author has found, since the paper was read, to give circular crystals more easily and certainly than any other. Those from the solution in acetic acid are the finest. The black concentric circles, indicating absence of matter, are peculiarly marked; and the sectors shade off so perfectly into the arms of the cross, as to give the discs the appearance of being formed of four solid cones. The discs are sometimes elongated into conical forms, with the black cross at the summit. A crust of opaque crystalline matter, that is, not in optical contact, often covers them, and often breaks off, shewing the circular crystal below. The cones have frequently two, three, or four black arches crossing them. In some of the larger discs, each successive ring is formed of radiating branches, radiating from the margin of the ring within.

17. *Oxalurate of Ammonia (pure).*—This salt, to which the author's attention was called by Professor Gregory, gives beautiful negative circular crystals, and rarely fails to yield them. With weak solutions the discs are small and exactly resemble those of the lithoxanthate of ammonia. Professor Gregory thinks that the two salts are identical, but that the lithoxanthate contains a little colouring matter. With strong solutions, the salt yields discs often nearly opaque, but surrounded by concentric rings of marginal radiations, of different tints. In some large crystals, the central circle consists of green of the second order, with a faint black cross, descending to the white of the first order; the next ring, which is separated by a narrow black band from the first, exhibits the white, which rises to the yellow of the second order, and again descends to the white of the first, completing the second ring. Three similar rings follow in succession, and each of the five has a uniform tint throughout its circumference, proving a uniform thickness in each band. These crystals, when a number are seen in the dark field, are singularly beautiful. This salt yields cones like those of mannite, and these have, in the centre of the black cross, a second cross bisecting the luminous sectors.

18. *Hippuric Acid* gives fine circular crystals with alcohol. In these, the radial lines are often divided by black spaces as broad as the luminous lines; and the whole disc is covered with numerous minute concentric circles, at equal distances from one another. In

some cases, the discs consist of eight or ten sectors of uniform thickness, which become black in the plane of primitive polarization.

The following is the author's list of substances giving circular crystals.

1. *Positive Circular Crystals.*

Sulphate of ammonia and magnesia.
... ammonia and cobalt.
... ammonia and iron.
... ammonia and manganese.
... potash and zinc.
... red oxide of manganese.
Disulphate of mercury.
Hydrate of potash.
Citrate of potash.
Muriate of morphia.
... magnesia.
Muriate of strontia.
Almond soap.
Starch.
Substance in garnet.
... mica.
Mannite.
Citrate of ammonia.
Myristic acid.
Cupreo-sulphate of potash.
Kreatinine.

2. *Negative Circular Crystals.*

Borax in phosphoric acid.
Lithoxanthate of ammonia.
Oxalurate of ammonia, pure.
Kreatine.
Salicine.
Asparagine.
Manna.
Parmeline.
Palmine.
Palmic acid.
Esculine.
Berberine.
Cinchonine.
Theine.
Thionurate of ammonia.
Carbazotate of potash.
Hippuric acid.
Sulphate of copper and iron.
... ... and zinc.
... magnesia and potash.
... copper and ammonia.
... zinc and ammonia.
... zinc.
Substance in garnet.
Stearine.
Stearic acid.
Palmitic acid.
Oil of mace.
Animal fat.
Cacao butter.
Hatchetine.
White wax.
Chrysoleptinic acid.
Succinate of zinc.
Chromic acid.
Citric acid.
Nitrate of uranium.
... urea.
... brucine.
... strychnine.
Gallic acid.
Sulphuret (nitrate) of cadmium.
Sulphuret of potassium.
Santonine.
Acetate of strontia.
... quinine.
Chloride of zinc.
Oxide of uranium.
Protoxide of nickel.
Phosphate of nickel.
Carbonate of nickel.
Substance in mica.
Adipocere.
Margaric acid.
Ethal.

The following substances also exhibit circular polarization, and the structure is, in all cases but one, negative.

Hoof of the horse, vertical and transverse sections.
Hoof of an ass, transverse section.
Transparent aperture in the wing of a beetle.
Hoof of rhinoceros.
Horn of rhinoceros, transverse and vertical sections.
Horn of antelope.
Sections of hairs of animals.

In conclusion, the author offered some observations on the formation and destruction of these discs. He regarded them as abnormal crystallizations, in which the particles are in unstable equilibrium, and have a constant tendency to arrange themselves according to their natural polarities. Hence, circular crystallizations are apt, after a longer or shorter time, to disappear, the particles either dissolving, or assuming the form of ordinary crystals, lying in all directions, or accumulated in radial or circular lines. In oil of mace, the decomposition is effected in a night; in mannite, not for several years.

The observations recorded in this paper, have occupied the author during the last ten years, and must have an important bearing on many unsettled questions in molecular philosophy.

The following Donations to the Library were announced :—

Ordnance Survey. Astronomical Observations made with Airy's Zenith Sector, from 1842 to 1850, for the determination of the Latitudes of various Trigonometrical Stations used in the Ordnance Survey of the British Isles. By Captain W. Yolland. 4to.—*From the Hon. Board of Ordnance.*

Archives du Muséum d'Histoire Naturelle, publiées par les Professeurs-Administrateurs de cet Etablissement. Tome VI., Liv. 3 & 4. 4to.—*From the Editors.*

The American Journal of Science and Arts. 2d Series. No. 43. 8vo.—*From the Editors.*

Monday, 4th April 1853.

SIR T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read:—

1. On Nitric Acid as a source of the Nitrogen found in Plants.

By Dr George Wilson.

The author, after referring to the opinions of those who contend that plants derive their nitrogen only from ammonia, shewed, in justification of the belief, that they also derive that element from nitric acid:—

Firstly, That nitrates are largely offered to plants, both as they grow wild, and as they are artificially cultivated.

Secondly, That plants do not refuse the nitrates thus offered to them.

Thirdly, That the nitrates which enter plants do not, if properly diluted, do injury to any class of them.

Fourthly, That nitrates largely promote the growth of the most important plants.

Fifthly, That as chemists are at one in regarding the chief function of a plant, considered as a piece of chemical apparatus, to be the deoxidation of those oxides, such as water, carbonic acid, and sulphuric acid, which enter it, they cannot with any consistency deny that nitric acid, which is one of the most easily deoxidised of all oxides, must, more easily than the oxides referred to, part with its oxygen, and give up nitrogen to the plant.

Sixthly, That although it would be unwise to be dogmatic on the phenomena which occur within the recesses of a plant, or to affirm that it cannot derive nitrogen from many sources; yet, according to the present conclusions of science, it may be reasonably urged, that the simplest chemical expression which we can give to our belief regarding the source of the nitrogen which is so important to plants, must be, that the inorganic or mineral representative and parent of all the nitrogenous constituents of plants, and through them of animals, is neither ammonia alone, nor nitric acid alone, but the compound of both, *i. e.*, nitrate of ammonia.

2. Observations on the Amount, Increase, and Distribution of Crime in Scotland. By George Makgill, Esq. of Kemback.

The author read some "Observations on the Amount, Increase, and Distribution of Crime in Scotland," being the results of an analysis of the Official Tables of criminal offenders for the ten years ending 1850, and of the Prison Board Returns, compared with various statistical data.

The criminal tables of Scotland confirm, in many important particulars, the observations of M. Guerry, M. Quetelet, and Mr Joseph Fletcher, as to the causes of the occasional fluctuations in the amount of crime, the chief of which appear to be—1*st*, Scarcity of the chief articles of subsistence; 2*d*, Disturbances of commercial credit, and of the labour market; 3*d*, Political excitement.

Among the other results of the author's inquiry are the following:—

1. The ratio of crime to population is apparently one-tenth higher in England than in Scotland; but,—

2. In England this ratio has for many years been gradually diminishing, while in Scotland it is rapidly and steadily increasing.

3. This increase shews itself chiefly in crimes accompanied by violence, which in Scotland constitute 40 per cent. of the total offences recorded, while in England they are only 14 per cent.

4. This excess and increase are chiefly remarkable in the agricultural, pastoral, and thinly-peopled districts of the Border, where aggravated crimes against the person are greatly more common in proportion to population, than in the densely-crowded manufacturing counties of the west. In Berwick and Roxburgh, crime of all kinds has increased more rapidly in the last ten years, than in any other part of the country; while in Lanarkshire the augmentation has been trifling, and in Renfrew the number has actually diminished. An analogous fact has been observed in regard to England.

5. Looking, however, not to the ratio of *increase*, but to the *absolute amount* of crime in proportion to population, the highest counties are still those in which mining industry is found in conjunction with factory labour, with the exception of Ayr and Fifeshire.

6. There does not appear to be any marked coincidence between the excess of crime and that of pauperism.

7. The counties in which the number of licensed spirit-shops is greatest in proportion to population, are all distinguished for the frequency of crime; while those in which they are fewest are, with a single exception, greatly below the average of crime.

8. Excess in the proportion of real property to population is, in general, accompanied by excess of crime.

9. Eight out of the ten counties which stand highest in the list of serious crime, exhibit a proportion of school attendance considerably above the average of the country; while of the counties in which crime is *rarest*, all but two are greatly below the general educational standard.

10. The per-centage of female criminals is much larger in Scotland than in any European country of which the records are published. In France, the number of females in each 100 culprits is 15; in England, 19; and in Scotland, 28.

11. A marked decrease in the number of juvenile offenders in the large towns has been going on for the last six or seven years.

12. There is a remarkable uniformity from year to year in the *results* of criminal proceedings; the proportion of convictions to trials never having varied in the last four years more than one per cent.

13. The number of sentences under the aggravation of previous conviction has been steadily and rapidly increasing for the last fifteen years; indicating either greater efficiency of the police, or insufficiency in the character of punishment.

14. In the last half of the ten years under review, the number of cases in which *insanity* has been successfully pleaded in bar of trial, is more than double what it was in the first half; and the number of accused who have been found insane *on* trial, has multiplied nearly to the same extent.

The author concluded by regretting that the deficiency of statistical materials in Scotland, and in particular the total want of a system of registration, prevented the extension of the inquiry to many subjects of great public interest.

Monday, 18*th April* 1853.

JOHN CAY, Esq., Advocate, in the Chair.

The following Communications were read:—

1. Notice of recent Measures of the Ring of Saturn. By Professor C. Piazzi Smyth.

This communication chiefly described the observations made by W. S. Jacob, Esq., of the Madras Observatory, during the last apparition of the planet, with a telescope having a six-inch object-glass, lately completed by Lerebours and Secretan.

Previous to its being sent to India, the object-glass had been tested at the Edinburgh Observatory; and its quality, which was then approved, had been more conspicuously brought out in the subsequent trial in a clearer climate.

Immediately after the receipt of the object-glass, in September 1852, Mr Jacob directed it to Saturn, then in the zenith, and immediately perceived the "transparency" of the dark ring which has since been discovered independently by Mr Lassel and others; and on very accurately adjusting the focus, he saw a fine division in the outer dark ring. This appears to have escaped all other observers at the same time, except perhaps Mr Dawes, who had some suspicions of such a phenomenon. But Mr Jacob saw it clearly for all the rest of the apparition of the planet, could trace it through more than half the circumference of the ring, and was enabled to get good measures of it with the wire micrometer.

Such a fine division of the outer ring has not unfrequently been suspected before, and even seen, but only on one or two special nights, by each observer, and then merely through a very small part of the circumference at the ansæ.

Mr Jacob's observations, therefore, establish the fact permanently among the phenomena of the planet's appearance, and lead us to expect more still from him, when, as will be the case in a few years, the ring of Saturn is presented to our view at its maximum angle of inclination.

The author then concluded with an account of the most probable theory with regard to the material and economy of the rings, which he conceived to be fluid and vaporous, and indicating, with a certain variation, due, perhaps, to a magnetic or diamagnetic condition, the appearance of the earth in what Mr Nasmyth calls its "pre-oceanic" state; when, still incandescent, the ocean could find no resting-place on its surface, but would have been compelled to form a dense vapour envelope in the atmosphere; of frozen particles outside, by reason of the coldness of space, and of watery vapour inside, from the radiation of heat from the hot internal globe.

2. Chemical Notices. By Professor Gregory.

1. *On the new compounds of Cobalt described by Frémy and others.*

Claudet in London, and Genth in Germany, about the same time observed a new compound of cobalt, with the elements of ammonia and chlorine. Frémy, about the same time, announced a far more extended investigation, the result of which was the discovery of no less than five series of salts, in some of which the base, with oxygen acids, was formed of oxides of cobalt along with more or less ammonia, and, with hydrogen acids, was formed of cobalt with more or less ammonia. In other series, salts of oxides of cobalt, for the most part previously unknown oxides of this metal, seem to have combined with more or less ammonia. I shall not enter farther into any details of the views of Frémy, in regard to many of these salts, which are very complicated, and confessedly provisional. But I have made some experiments on the formation and analysis of two of the most remarkable of the salts described by him, one of which belongs to the series of Roseocobaltiak, the other to that of Luteocobaltiak. Both are chlorides or hydrochlorates, and the former, or the pink salt, is the same as was described by Claudet and Genth. I find that both this and the other—which is yellow, a very unexpected fact in compounds of cobalt—may easily be obtained by dissolving protochloride of cobalt in water, adding sal-ammoniac and an excess of ammonia, and passing chlorine through the solution, till the chlorine is in excess. It then deposits a mixed mass of pink and yellow salt, which may be separated by the greater solubility of the yellow salt in water very slightly acidulated with hydrochloric acid, in which the pink salt is almost insoluble. The yellow salt may be obtained in large and fine crystals by spontaneous evaporation. When large, the crystals are of a deep orange-red, but the powder and the small crystals are bright orange-yellow. The red salt is sparingly soluble in hot water, which, on cooling, deposits it in dark red crystals of small size. It is generally obtained, however, as a crystalline powder of a fine pink colour, as it is usually rapidly formed, and deposited too quickly to form regular crystals.

The chemists who have analysed the red or pink salt are not agreed as to its composition, for while Claudet found it to contain no oxygen and no water, Frémy admits 1 eq. of water, and Genth considers it as a compound of sesquioxide of cobalt, ammonia, and chlorine. I have made a number of analyses of this salt, prepared in different ways, and when it has been slowly ignited in a current of hydrogen, to determine the cobalt which is left in the metallic state, I have not in any case obtained a trace of water. Consequently the salt cannot have the formula given to it by either Genth or Frémy. As that of Genth is absolutely erroneous, I shall give here the empirical formulæ of Frémy and Claudet, with my own results.

Claudet, ...	$Co_2\,Cl_3\,N_5\,H_{16}$
Frémy, ...	$Co_2\,Cl_3\,N_5\,H_{16}\,O$
Gregory, . . .	$Co_2\,Cl_3\,N_5\,H_{15}$

	Claudet.		**Frémy.**		**Gregory.**	
	Theory.	Experiment.	Theory.	Experiment.	Theory.	Experiment.
Co	23·16	23·50	22·8	22·6	23·55	23·79
Cl	42·34	42·38	41·0	40·9	42·51	42·86
N	27·83	27·79	27·0	26·2	27·94	28·00
H	6·36	6·34	6·1	6·4	5·98	6·00
O	...	...	3·1	3·1	...	...

It is very difficult to form any distinct idea of the rational formula, whichever empirical one we adopt. The most interesting point is this, that from this compound analogous ones with oxygen acids may be formed, and that from these, by the action of alkalies, a base may be separated, although it has not yet been isolated in a state of purity, which appears to consist of ammonia *plus* some oxide of cobalt. If such bases exist, they will probably, like other oxidised bases, yield, with hydrochloric acid, water and chlorides, and thus our red salt would be the chloride of the radical, which, with oxygen, forms the base in the oxidised salts. But we must not dwell on possibilities; and my object is to shew, first, that the red compound does not, as Frémy states, contain oxygen (at least that which I have examined), and that before we can speak with confidence as to its true formula, we must have more certainty as to the empirical one.

With regard to the yellow salt, this, according to Frémy, contains no oxygen, and 1 eq. of ammonia more than the red salt. My results lead to the same conclusion, so that its empirical formula appears to be $Co_2\,Cl_3\,N_6\,H_{18}$, or $Co_2\,Cl_3 + 6\,NH_3$. It also forms salts with oxygen acids, and from these an oxidised base may be separated, but has not been fully studied.

All the three authors who have preceded me describe the crystals of the red salt as regular octohedrons, and they must be very nearly so; but Sir D. Brewster informs me that they do act to a small extent on polarized light, in which case they cannot belong to the regular system.

Frémy, differing from Genth, also describes the yellow salt as forming regular octohedrons. But this is, I think, a mistake; for, as far as I have examined them, they appear to be prismatic. Genth describes the crystals as rhombic or klino-rhombic.

2. *On the Acid formed when Potash acts on Oil of Bitter Almonds.*

When commercial oil of bitter almonds is mixed with an excess of an alcoholic solution of potash, there is formed, instead of benzoine, a salt, crystallising in scales, which are very soluble in alcohol. This salt is said in books to be benzoate of potash. And when decomposed by acids, it yields an acid which, to all appearance, is benzoic acid. But it is worthy of notice, that if we form benzoate of potash with common benzoic acid, the salt is hardly at all soluble in hot alcohol, and does not crystallise in the same way as the salt above mentioned; indeed can hardly be got to crystallise at all. I have made many experiments to ascertain the cause of this strange difference, but I have as yet been unable to detect it. The salt I exhibit has been three times recrystallised from alcohol, and is as soluble as ever; while yet the acid extracted from it appears identical with benzoic acid. Its analysis, indeed, does not perfectly agree with that of benzoic acid, but the difference is so slight, as not to affect the formula.

Is it possible that the presence of some foreign matter communicates to the potash salt the property of solubility in alcohol, and that of crystallising readily? But if so, the more it is purified, the less soluble it should become. This I have not found to be the case. I rather suspect that the acid is not truly benzoic acid, and that a more minute investigation will detect its true nature. Its resemblance to benzoic acid is certainly very striking, but we know that homologous compounds, although different in composition, often resemble each other in as great a degree.

3. *On a spontaneous Metamorphosis of Alloxan.*

I have found that alloxan forms two kinds of hydrated crystals. Those, with six eqs. of water, are large, regular, transparent, and do not readily effloresce in the air, nor undergo any change when kept. But there is another form much more frequent, which, according to my analysis, contains seven or possibly eight eqs. of water. It forms large but irregular masses, with their sides graduated like steps, and effloresces on exposure to the air very readily. I rather think this kind forms in solutions which are slightly acid from free nitric acid, which is likely to be the case in preparing alloxan. When placed in stoppered bottles, and exposed to the natural changes of temperature in summer, these crystals became partially liquified, and after a year or two I found the contents of several bottles entirely changed. A very large part had become nearly insoluble in cold water, and the solution filtered from this part deposited, on evaporation, *first*, small colourless crystals; *secondly*, a crystalline and yellowish mass; and, last of all, the little remaining liquid dried up into a tough semi-crystalline mass, which became pink on exposure to the air of the laboratory.

I find the insoluble, or sparingly soluble matter, to be pure alloxantine. The next crystals are quite distinct, both in form and properties, and the following portions exhibit also characters of their own. No alloxan has appeared. But since the difference between alloxan and alloxantine is simply that the latter contains one eq. of hydrogen more than the former, then the other substances must either contain less hydrogen than alloxan, or, if the hydrogen has been derived from water, they must contain more oxygen. I regard the latter as the probable case, and I rather think that the new product or products are of an acid nature. But I have not yet been able to obtain them pure; and if I had, the difference in composition is so small, that analysis will hardly suffice to make sure of it. We must therefore have recourse to the difference of properties, and here all that I have as yet been able to do is to ascertain that besides alloxantine, at least one, but probably two substances have been formed, different both from alloxan and from alloxantine, as well as from all the allied compounds with which I am acquainted; and that one if not both of these are acid compounds. The investigation is one of very great difficulty, from the tendency of all these compounds to be altered by contact with other substances, or by heat, and from the great similarity in the properties of many of them.

One useful hint which the chemist may derive from these observations is, that if he wishes to preserve alloxan, it ought to be got in the anhydrous form, which is done by evaporating its solution at 140° or 150°, when anhydrous crystals alone are deposited in the warm solution, which is poured off and further evaporated, as long as it yields crystals. It is apt to be decomposed at higher temperatures.

3. Observations on the Structural Character of Rocks. Part II. By Dr Fleming.

In proceeding to consider still farther the physiology of rocks, the author proposed in this communication to confine himself to the illustration of

1. *The Columnar Structure.*—After enumerating examples of this structure, as occurring in the neighbourhood of Edinburgh, in cannel coal, sandstone, clay, ironstone, clinkstone, claystone, greenstone, and basalt, he exhibited examples of similar appearances in oven soles and fragments of the walls of vitrified forts. The ordinary explanation of this structure as the result of cooling from a state of fusion he pointed out as unsatisfactory, even in the case of basaltic pillars, and inapplicable to similar appearances as occurring in sedimentary rocks. He considered the whole phenomena explicable as connected with one cause, viz., shrinkage, arising from the escape of aqueous or volatile matter.

2. *The Cone in Cone Structure.*—Examples of this structure occur in impure ferruginous limestone at Joppa, the Water of Leith, and other places, in connection with the coal measures. The author referred the origin of this structure to shrinkage, conjoined with a certain amount of molecular aggregation, or crystallising influence.

4. Some Observations on Fish, in relation to Diet.
By Dr John Davy.

In this communication the attention of the author is chiefly directed to two subjects of inquiry :—

1*st*, The comparative nutritive power of fish, taking the specific gravity of their substance, and the proportion of solid matter left on thorough drying, as a measure of the same. In illustration, two tables are given, containing the results of trials on several kinds of fish and other articles of animal food; from which he deduces that the difference of nutritive power of these several articles, has commonly been overrated.

2dly, The peculiar qualities of fish, if any, as articles of diet. On this head, excusing himself from entering into details from want of sufficient data, he expresses the opinion that fish, as diet, are not without specific power, conducive to health, and the prevention of certain diseases, especially scrofula, pulmonary consumption, and goître. He founds this opinion partly on experience,—the absence or comparative rarenesss of these diseases amongst people using such a diet; and partly on the circumstance, that iodine in minute quantity enters into the composition of sea-fish, having found traces of it in every instance of these fish in which he has specially sought for it; an opinion, moreover, he thinks strengthened by the fact, that the same element, iodine, exists in cod-liver oil, which has proved so serviceable, if not in curing, at least in mitigating pulmonary consumption.

The following Gentleman was duly elected an Ordinary Fellow:—

HUGH SCOTT, Esq. of Gala.

The following Donations to the Library were announced:—

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, 1852–3. 4to.—*From the French Government.*

Memorie della Accademia delle Scienze dell' Instituto di Bologna. Tom. II. 4to.—*From the Academy.*

Rendendrionto delle Aduvanze e de' Lavori della Reale Accademia delle Scienze sezione della Societa Reale Borbonica. N.S. Nos. 1–5. 4to.

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Relazione Lalla Malattia della Vite apparsa nei contorni di Napoli ed altri luoghi della Provincia fatta da una commissione della Reale Accademia delle Scienze. 4to.—*From the Academy.*

Opuscula Matematici di Tito gonella. 4to.—*From C. Babbage, Esq.*

The Assurance Magazine, and Journal of the Institute of Actuaries. No. 11. 8vo.—*From the Institute.*

Catalogue of a Collection of Ancient and Mediæval Rings and Personal Ornaments formed for Lady Londesborough. 4to.—*From Lord Londesborough.*

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ROYAL SOCIETY OF EDINBURGH.

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